CLAIMS

What is claimed is:

1. An optical apparatus, comprising:
   a) an input port, providing a multi-wavelength optical signal;
   b) an output port;
   c) a wavelength-disperser that separates said multi-wavelength optical signal by wavelength into multiple spectral channels having a predetermined relative arrangement; and
   d) an array of micromirrors positioned such that each micromirror receives a unique one of said spectral channels, said micromirrors being individually pivotable such that optical power levels of said spectral channels coupled into said output port carry distinct dither modulation signals.

2. The optical apparatus of claim 1 further comprising an optical detector, optically coupled to said output port, wherein said optical detector converts said optical power levels into an electrical signal.

3. The optical apparatus of claim 2 further comprising a synchronous detection unit, in communication with said optical detector, wherein said synchronous detection unit detects from said electrical signal said dither modulation signals in said optical power levels.

4. The optical apparatus of claim 3 further comprising a signal processor, containing a predetermined calibration table, said signal processor deriving an optical power spectrum of said multi-wavelength optical signal from said dither modulation signals.

5. The optical apparatus of claim 2 wherein said optical detector comprises a photodiode in conjunction with an associated detection circuit.

6. The optical apparatus of claim 1 wherein said output port comprises a spatial filter, configured such that as said micromirrors are pivoted about respective nominal positions by a set of mirror-control signals, said dither modulation signals are produced in said optical power levels.

7. The optical apparatus of claim 6 wherein said optical power levels of said spectral channels coupled into said spatial filter are at respective maximum values when said micromirrors are at said nominal positions.

8. The optical apparatus of claim 6 wherein said mirror-control signals include dither components, said dither components being mutually orthogonal functions of time.

9. The optical apparatus of claim 6 wherein said mirror-control signals include dither components, classified in a plurality of distinct dither groups, wherein each dither group contains dither components that are mutually orthogonal functions of time, and wherein said optical apparatus further comprises one or more auxiliary spatial filters, such that said spectral channels coupled into each spatial filter carry distinct dither modulation signals.

10. The optical apparatus of claim 6 wherein said spatial filter comprises an element selected from the group consisting of fiber collimators and apertures.

11. The optical apparatus of claim 1 wherein said micromirrors comprise silicon micromachined mirrors.

12. The optical apparatus of claim 1 wherein said wavelength-disperser comprises an element selected from the group consisting of ruled diffraction gratings, holographic diffraction gratings, echelle gratings, curved diffraction gratings, transmission gratings, and dispersing prisms.

13. The optical apparatus of claim 1 further comprising a beam-focuser for focusing said spectral channels into corresponding focused spots that impinge onto said beam-modulating elements.

14. The optical apparatus of claim 1 further comprising a reference signal, emerging from said input port along with said multi-wavelength optical signal, wherein said wavelength-disperser directs a reference spectral component of said reference signal to a predetermined location on a reference-position-sensing element.

15. The optical apparatus of claim 14 wherein said reference-position-sensing element comprises an element selected from the group consisting of position sensitive detectors, quadrant detectors, and split detectors.

16. The optical apparatus of claim 14 wherein said reference-position-sensing element comprises two reference-beam-modulating elements, configured to introduce distinct reference dither modulation signals in an optical power level of said reference spectral component.

17. The optical apparatus of claim 14 wherein said input port comprises a fiber collimator coupled to an input optical fiber, wherein said optical apparatus further comprises an optical combiner for coupling a reference light source to said input optical fiber, and wherein said input optical fiber transmits said multi-wavelength optical signal and said reference light source provides said reference signal.

18. The optical apparatus of claim 14 further comprising an alignment-adjusting element for adjusting an alignment between said spectral channels and said beam-modulating elements.

19. The optical apparatus of claim 18 wherein said beam-modulating elements and said reference-position-sensing element form an optical-element array, and wherein said

alignment-adjusting element comprises an actuation device coupled to said optical-element array, for causing said optical-element array to move.

20. The optical apparatus of claim 19 further comprising a processing element in communication with said alignment-adjusting element and said reference-position-sensing element, wherein said processing element monitors an impinging position of said reference spectral component onto said reference-position-sensing element and provides control of said alignment-adjusting element accordingly, so as to maintain said reference spectral component at said predetermined location, thereby ensuring a requisite alignment between said spectral channels and said beam-modulating elements.

21. The optical apparatus of claim 1 wherein said input port comprises a fiber collimator.

22. The optical apparatus of claim 21 wherein said output port comprises a fiber collimator.

23. An optical apparatus, comprising:

a) an input port, providing a multi-wavelength optical signal;

b) first and second output ports;

c) a polarization-separating element that decomposes said multi-wavelength optical signal into first and second polarization components;

d) a polarization-rotating element that rotates a polarization of said second polarization component by approximately 90-degrees;

e) a wavelength-disperser that separates said first and second polarization components by wavelength into first and second sets of optical beams, respectively;

f) a beam-focuser that focuses first and second sets of optical beams into corresponding focused spots; and

g) an array of beam-modulating elements configured to direct said first and second sets of optical beams into said first and second output ports,

respectively, said beam-modulating elements being individually controllable such that optical power levels of said first and second sets of optical beams coupled respectively into said first and second output ports carry distinct dither modulation signals.

24. The optical apparatus of claim 23 further comprising first and second optical detectors, optically coupled to said first and second output ports, respectively.

25. The optical apparatus of claim 24 further comprising first and second synchronous detection units in communication with said first and second optical detectors, respectively.

26. The optical apparatus of claim 23 wherein said beam-modulating elements comprise micromirrors and said first and second output ports comprise first and second spatial filters, configured such that as said micromirrors are pivoted about respective nominal positions by a set of mirror-control signals, said dither modulation signals are produced in said optical power levels of said first and second sets of optical beams, respectively.

27. The optical apparatus of claim 26 wherein said mirror-control signals include dither components, said dither components being mutually orthogonal functions of time.

28. The optical apparatus of claim 26 wherein said first spatial filter comprises an element selected from the group consisting of fiber collimators and apertures.

29. The optical apparatus of claim 28 wherein said second spatial filter comprises an element selected from the group consisting of fiber collimators and apertures.

30. The optical apparatus of claim 26 wherein said micromirrors comprise silicon micromachined mirrors.

31. The optical apparatus of claim 23 wherein said beam-modulating elements comprise spatial light modulators.

32. The optical apparatus of claim 31 wherein said spatial light modulators comprise electro-optic modulating elements in conjunction with a beam-reflector.

33. The optical apparatus of claim 23 wherein said polarization-separating element comprises an element selected from the group consisting of polarizing beam splitters and birefringent beam displacers.

34. The optical apparatus of claim 23 wherein said polarization-rotating element comprises an element selected from the group consisting of half-wave plates, liquid crystal rotators, and Faraday rotators.

35. The optical apparatus of claim 23 wherein said wavelength-disperser comprises an element selected from the group consisting of ruled diffraction gratings, holographic diffraction gratings, echelle gratings, curved diffraction gratings, transmission gratings, and dispersing prisms.

36. The optical apparatus of claim 23 wherein said beam-focuser comprises at least one focusing lens.

37. The optical apparatus of claim 23 wherein said input port comprises a fiber collimator.

38. The optical apparatus of claim 37 wherein said first output port comprises a fiber collimator.

39. The optical apparatus of claim 38 wherein said second output port comprises a fiber collimator.

40. An optical apparatus, comprising:

a) an input port, providing a multi-wavelength optical signal;

b) a polarization-separating element that decomposes said multi-wavelength optical signal into first and second polarization components;

c) a polarization-rotating element that rotates a polarization of said second polarization component by approximately 90-degrees;

d) a wavelength-disperser that separates said first and second polarization components by wavelength into first and second sets of optical beams, respectively;

e) a beam-focuser that focuses said first and second sets of optical beams into corresponding focused spots; and

f) an array of spatial light modulators configured to direct said first and second sets of optical beams into first and second optical detectors, respectively, said spatial light modulators being individually controllable such that optical power levels received respectively by said first and second optical detectors carry distinct dither modulation signals.

41. The optical apparatus of claim 40 further comprising first and second synchronous detection units, in communication with said first and second optical detectors, respectively.

42. The optical apparatus of claim 40 wherein said spatial light modulators comprise electro-optic modulating elements, in conjunction with a beam-reflector.

43. The optical apparatus of claim 40 wherein said polarization-separating element comprises an element selected from the group consisting of polarizing beam splitters and birefringent beam displacers.

44. The optical apparatus of claim 40 wherein said polarization-rotating element comprises an element selected from the group consisting of half-wave plates, liquid crystal rotators, and Faraday rotators.

45. The optical apparatus of claim 40 wherein said wavelength-disperser comprises an element selected from the group consisting of ruled diffraction gratings, holographic diffraction gratings, echelle gratings, curved diffraction gratings, transmission gratings, and dispersing prisms.

46. The optical apparatus of claim 40 wherein said input port comprises a fiber collimator.

47. A method of spectral modulating and monitoring using a frequency-division-multiplexing scheme, comprising:

a) providing a multi-wavelength optical signal;

b) separating said multi-wavelength optical signal by wavelength into multiple spectral channels having a predetermined relative arrangement; and

c) impinging said spectral channels onto an array of micromirrors such that each micromirror receives a unique one of said spectral channels; and

d) pivoting said micromirrors individually such that optical power levels of said spectral channels coupled into an output port carry distinct dither modulation signals.

48. The method of claim 47 further comprising the step of performing synchronous detection of said dither modulation signals in said optical power levels.

49. The method of claim 48 further comprising the steps of converting said optical power levels to an electrical signal and detecting from said electrical signal said dither modulation signals in said optical power levels.

50. The method of claim 48 further comprising the step of performing a calibration, whereby an optical power spectrum of said multi-wavelength optical signal is obtained from said dither modulation signals.

51. The method of claim 47 wherein the said micromirrors are individually pivoted about respective nominal positions by way of a set of mirror-control signals, thereby producing said dither modulation signals in said optical power levels.